

# Research on Sino-British Trade Efficiency and Potential

-- Based on Stochastic Frontier Gravity Model

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**Abstract:** On the basis of analyzing the bilateral trade combination, export concentration and complementarity between China and the UK, a stochastic frontier gravity model is used to measure the trade efficiency and potential between China and the UK, and a realization path for China-UK trade cooperation is proposed. It is found that: the bilateral trade volume between China and the UK is steadily increasing, but the growth of UK exports to China is sluggish and the trade deficit is expanding year by year; the trade links between China and the UK are relatively loose, but there is a trend of strengthening; the trade products are more complementary and the types of trade complementary goods between the two countries do not overlap; but the export concentration is high. The trade potential between China and the UK is expanding year by year, reaching 224.9 billion USD by 2019; trade efficiency is steadily increasing, but is significantly constrained by tariff barriers and average turnaround time of imports, while financial and commercial liberalization can significantly improve the trade efficiency between the two countries. It is recommended to strengthen cooperation with the UK in the financial sector, expand imports of service products to the UK, and promote the construction of a free trade zone between the two countries at an appropriate time.

**Keywords:** Trade potential, Efficiency, Stochastic frontier, Sino-British.

## 1. Introduction

Since 1973, the United Kingdom has been the European Community, upgraded to the European Union in 1991. The UK followed the wave of European economic integration and realized the integration process with Germany, France and other developed European countries to reach a common trade barrier. Since then, the study of trade cooperation with the UK has become less meaningful and shifted to the study of trade cooperation with the EU. However, in 2019, the UK government proposed in the White Paper on the UK's Exit from the EU and a New Partnership with the EU that the UK would be able to freely establish FTAs with other countries after Brexit. With the completion of the UK's exit from the EU in January 2020, the UK has been freed from the restrictions of the EU's unified trade policy and regained its independence and autonomy in formulating trade policies. As the EU has been reluctant to develop deep trade cooperation with China, the UK's exit from the EU has undoubtedly brought an opportunity for China-UK trade cooperation. From 2001 to 2017, bilateral trade between China and the UK continued to grow, with total trade between the two countries expanding by nearly 6.6 times, and China has become the UK's second largest importer in addition to the EU. By 2019, China is already the 3rd largest trading partner of the UK, after the US and Germany. And it is the 3rd largest importer and the 5th largest exporter of the UK. And the UK is China's 13th largest trading partner and 8th largest exporter.

In recent years, studies on Sino-British trade cooperation have been roughly divided into two periods, pre-Brexit and post-Brexit, taking the time of Britain's exit from the EU as the time point. In the pre-Brexit period, because the UK belongs to the EU member states and the whole EU has common trade barriers, there are fewer studies on Sino-British trade cooperation, mainly in the following aspects: Zhan Ruo (2010) analyzed the current situation of Sino-

British trade and believed that with the upgrading of China's economic structure and the reduction of China's tariffs under the WTO framework, the trade between the two countries has a promising future. Dai Zhen (2010) analyzed the difference of trade in intermediate goods between China and Britain, and concluded that as the technology intensity of products increases, the higher the proportion of intermediate goods in this product that China exports to Britain, while China imports the most intermediate goods in medium-technology industries to Britain, followed by intermediate goods in high-technology industries.

After Brexit, studies on Sino-British trade cooperation have focused on the following four aspects: first, the role and influencing factors of Sino-British trade cooperation. Liu Yi et al. (2016) argued that Sino-British trade cooperation is beneficial to the complementary advantages of the two countries' industries and promotes mutual development. Xing Lirong et al. (2017) analyzed the growth factors of China-UK industrial manufactured goods trade using CMS model and found that the competitiveness of export commodities and the improvement of import demand can promote the growth of bilateral industrial manufactured goods trade, but the good structure of import demand and the complementarity of export commodity structure have a decreasing trend thus inhibiting the development of bilateral trade. Yang Cui (2017) argues that the difference in the structure of Sino-British tea trade and the fluctuation of the RMB have constrained the development of bilateral tea trade and caused an increase in anti-dumping investigations of British tea exports to China.

Second, the possible impact of Brexit on the economic and trade development of China and the UK. Wang Yuanxue et al. (2016) argue that Brexit may not only increase the risk of China's exports and investments to Europe, but may also bring opportunities for China-UK and China-EU to reach FTAs, which in turn will promote bilateral investment and RMB internationalization. Xu Zerong (2017) argues that

Brexit will improve the UK's terms of trade and promote its exports to China; while in terms of service trade, Brexit provides an opportunity for financial services cooperation between China and the UK, but may bring trade losses to China due to the late start and low level of development of China's service trade. Zhang Yanfeng (2017) also believes that Brexit may cause a plunge in the exchange rate of the British pound, which provides an opportunity for China-UK trade and China's acquisition of high-quality assets in the UK, but because the UK is a world financial center, the financial shock that may be triggered by Brexit will affect China. Li Yuan (2017) argues that after Brexit, the scale of bilateral import and export trade between China and the UK will expand and the trade balance between the two countries will have a tendency to narrow, and there will be new changes in China-UK trade policies. Liu Jun et al. (2017) believe that Brexit will have little impact on China's investment to the UK, but will have a significant negative impact on China-UK and even China-EU foreign trade. Ren Zaiping (2017), on the other hand, analyzed the opportunities and challenges brought by Brexit to China's cooperation with CEE16 countries. Wang Yuanxue (2017) used an empirical approach to explore the impact of Brexit on China and found that Brexit would lead to a trade diversion effect in the UK, which would promote the expansion of China's trade with the Belt and Road countries, especially the growth of China's exports to the UK.

Third, the opportunity and prospect of establishing a FTA between China and the UK. Fan Xiyu et al. (2016) firstly proposed that Britain's exit from the European Union brings an opportunity for China and Britain to start FTA negotiations, and provides a direction for the establishment of a Sino-British FTA that draws on the experience of the China-Korea FTA and avoids the "high standard" clause to establish a free trade area with appropriate standards. However, Yao (2017), while agreeing that Brexit has brought a new dimension to Sino-British economic and trade cooperation, suggests that it is necessary for both sides to promote a high-level bilateral FTA agreement covering investment and services. Han Jian (2020), on the other hand, looks forward to the prospect of a Sino-British FTA and believes that the construction of a FTA between the two sides has great potential and is in the common interest of both sides, and that both sides should cooperate pragmatically and take the bilateral investment agreement as a breakthrough to gradually strengthen trade and investment cooperation.

Fourth, the risks brought by Brexit for Sino-British trade cooperation. Xu Jianwei et al. (2017) argue that China will gain less trade benefits from Brexit, and the promotion of FTA negotiations between China and the EU is very limited in the short term; and it is also difficult for the Sino-British FTA agreement to provide opportunities for Chinese goods to enter the European market, and thus some Chinese companies may divest from the UK and invest in other EU countries. Zhu Qinghua et al. (2021) found that after Brexit, the FTA between the UK and the EU will lead to a decline in China's economy and welfare, but with the increase in bilateral trade barriers between the UK and the EU, China's economy and welfare have increased, and China's trade volume has increased but has a deficit trend; while the UK will have a negative effect on China's trade and welfare if it signs FTAs with the US and New Zealand and joins the CPTPP.

Literature combing reveals that scholars' research on Sino-British trade cooperation was less before the UK's exit from the EU; after the exit, the existing research literature mainly

focuses on analyzing the impact of the UK's exit on Sino-British trade and investment, and the opportunities brought by the exit, and mostly belongs to qualitative analysis, lacking quantitative research on the potential and efficiency of Sino-British trade. In view of this, the author analyzes the competitiveness and complementarity of China-UK export commodities through some trade indices, and empirically studies the potential of trade cooperation between China and UK and the factors influencing trade efficiency, which is a powerful supplement to the relevant literature and can provide a reference basis for the realization of the potential of China-UK trade cooperation in the future.

## 2. Current Status of Sino-British Trade

As shown in Table1 (Appendix table), from 2007 to 2019, the total trade between China and Britain was less negatively affected by the financial crisis in 2008 and the low growth of the world economy, and overall all showed a continuous growth trend, from 39.247 billion U.S. dollars in 2007 to 92.312 billion U.S. dollars in 2019, with an average annual growth rate of 7.39%; only a slight decline in the two years of 2009 and 2016, after which the two Bilateral trade between the two countries rapidly resumed growth, and the growth trend of trade between the two countries is good. Specifically, China's exports to the UK increased from USD 31.166 billion in 2007 to USD 62.276 billion in 2019, an increase of about two times. UK exports to China ranged from \$7.581 billion to \$30.036 billion, an increase of nearly four times, and although faster than the growth rate of China's exports to it, the UK is still in a trade deficit position. In 2007, China's trade surplus with the UK was only \$24.086 billion, and by 2019, it had expanded to \$32.24 billion. In terms of trade share, China's exports to the UK as a percentage of China's total exports are generally on a steady, slight decline. It declined from 2.6% in 2007 to 2.49% in 2019, with the highest share of only 2.65% in 2016. The share of UK exports to China in total UK exports declined only slightly in 2016 and had an overall incremental trend, from 1.67% in 2007 to 6.47% in 2019, which indicates that trade cooperation between the two countries is deepening and UK exports are more dependent on the Chinese market and the dependence is getting deeper. By comparing the share of China's exports to the UK with the share of China's exports, and the share of UK exports to China with the share of UK exports, it is found that the share of China's exports to the UK is always much smaller than the average share of China's exports, and the gap has a tendency to widen; while the gap between the share of UK exports to China and the share of UK exports is getting smaller and smaller, and in 2019 it surpassed the average share of UK exports, indicating that the UK's exports to China Export potential is gradually released, and the potential that can be exploited later is smaller, while China's export potential to the UK is larger.

## 3. Dynamic Evolution of Sino-British Trade Relations

### 3.1. Trade integration degree

The trade integration index is often used to measure the degree of trade linkage or trade dependence between two countries. The formula is  $TII_{ij}=(X_{ij}/X_i)(M_j/M_w)$ , with a value of 1 as the critical value, greater than 1 means that the two countries have strong trade ties, otherwise the two countries have poor trade ties. The numerator of the equation is the

share of a country's exports to the partner country in that country's exports, and the denominator is the share of the partner country's imports in world imports.

As can be seen through Table2 (**Appendix table**), from 2007 to 2019, China's export trade bond to the UK and the UK's export trade bond to China have shown an increasing trend, and the China's export trade bond to the UK is greater than the UK's export trade bond to China. Specifically, China's export trade bond with the UK increased from 0.35 in 2007 to 0.44 in 2019, an increase of 25.7%. The trade union of UK exports to China ranged from 0.17 to 0.38, an increase of 2 times. And the trade bond between China and Britain are much less than the critical value of 1, indicating that the trade closeness between China and Britain is low, but the trade relationship is getting closer, and there is room for further trade cooperation between the two countries.

### 3.2. Export Concentration

Export concentration is usually used to measure the degree of concentration in the types of goods exported or the degree of diversification of exported goods between two countries. The author uses the Hirschman index to express the export concentration between China and the UK. Its formula is:

$$HI_{ij} = \sqrt{\sum_k (X_{ijk} / X_{ij})^2} \quad (1)$$

Where,  $HI_{ij}$  is the concentration index of exports from country  $i$  to country  $j$ , and its value ranges from 0 to 1. The larger the value, the more concentrated the types of exported commodities are.  $X_{ijk}$  is the export value of  $k$  products from country  $i$  to Country  $j$ , and  $X_{ij}$  is the total export value of country  $i$  to country  $j$ .

As can be seen from Table 3 (**Appendix table**), from 2007 to 2019, China's export trade concentration to the UK and the UK's export trade concentration to China are generally relatively stable and slightly decreasing, and China's export trade concentration to the UK is greater than the UK's export trade concentration to China. Specifically, the concentration of China's export trade to the UK declined from 0.58 in 2007 to 0.56 in 2019, a decline of just 0.02. and consistently greater than the critical value of 0.5, indicating that China's exports to the UK are more concentrated in certain products. The trade concentration of UK exports to China is between 0.5 and 0.46, slightly decreasing by 0.04. And the trade concentration of UK exports to China is only less than the critical value of 0.5 in 2018 and 2019, indicating that UK exports to China are also concentrated in certain products are, and there is room for further trade cooperation between the two countries.

### 3.3. Trade Complementarity Index

The trade complementarity index is an indicator of the degree of trade complementarity and closeness of trade relations, which can reflect to some extent the potential for export expansion between the two countries. The author uses a trade complementarity index that includes the relative disadvantages and relative advantages of the bilateral exports of the two countries is considered. When the trade complementarity index is greater than 1, it indicates that the complementarity between the exporting country and the

importing country is higher than the average level of other markets, and the trade relationship between the two countries is closer; when the index is less than 1, it indicates that the trade relationship between the two countries is looser. The formula is:

$$TCI_{ij} = \sum_k C_{ijk} * (X_{wk} / X_w) \quad (2)$$

$$C_{ijk} = RCA_{eik} * RCA_{mjk} \quad (3)$$

$$RCA_{eik} = \frac{X_{ik}}{X_i} * \frac{X_w}{X_{wk}} \quad (4)$$

$$RCA_{mjk} = \frac{M_{jk}}{M_j} * \frac{X_w}{X_{wk}} \quad (5)$$

where  $TCI_{ij}$  is the composite trade complementarity index between country  $i$ 's exports and country  $j$ 's imports;  $C_{ijk}$  is the trade complementarity between country  $i$ 's exports and country  $j$ 's imports on commodity category  $k$ ;  $RCA_{eik}$  is the comparative advantage of country  $i$ 's exports;  $RCA_{mjk}$  is the comparative disadvantage of country  $j$ 's exports;  $X_{ik}$  is the export value of commodity category  $k$  of country  $i$ 's exports;  $X_{jk}$  is the import value of commodity category  $k$  of country  $j$ 's imports;  $X_{wk}$  is the world is the amount of exports of goods of category  $k$ ;  $X_i$  is the amount of exports of country  $i$ ;  $M_j$  is the amount of imports of country  $j$ ;  $X_w$  is the amount of exports of the world.

As can be seen from Table 4 (**Appendix table**), from 2007 to 2019, the composite trade complementarity index between China's exports and the UK's imports declined slightly in a stable manner, from 1.01 in 2007 to 0.93 in 2019. but generally around the critical value of 1, indicating that complementarity exists in general for China's exports to the UK. The overall performance of the composite trade complementarity index between UK exports and Chinese imports is relatively smooth, varying between 0.93 and 0.98, i.e. fluctuating around the critical value of 1, indicating that complementarity also exists in general for products exported from the UK to China. Therefore, there is a basis for further trade cooperation between China and the UK.

As can be seen from Table 5 (**Appendix table**), from 2007 to 2019, only SITC6, SITC7, and SITC8 exceeded 1 in the complementarity index of various products between Chinese exports and UK imports, indicating its strong trade complementarity in Chinese exports and UK imports. Among them, SITC8 has the strongest complementarity, all of which exceed 2.

As can be seen from Table 6 (**Appendix table**), from 2007 to 2019, only SITC2, SITC3 and SITC5 exceeded 1 in the complementarity index of various products between British exports and Chinese imports, indicating that in British exports and Chinese imports it has a strong trade complementarity. Among them, SITC2 has the strongest complementarity, all exceeding 2. SITC7 fluctuates between 0.78 and 1.11 in complementarity, which is generally relatively stable and close to the critical value of 1. SITC9 has a gradually increasing trend of complementarity, from 0.13 in 2007 to 1.42 in 2019, and since 2011, its complementarity indices are

all greater than 1.

## 4. China-UK Trade Potential and Trade Efficiency Measurements

### 4.1. Export Concentration

The stochastic frontier approach was pioneered by Farrell (1957) and extended to panel data by Meeusen & Broeck (1977) and Aigner, Lovell & Schmidt (1977) for the study of technical efficiency of production. Later, Battese & Coelli (1992) constructed a time-varying decay model by estimating the technical efficiency of individual sample units over time, which enabled technical efficiency to vary over time. In recent years, scholars in the study of international trade problems, usually add the method to *GDP*, population, distance and other important factors affecting the volume of trade, then it is also improved to the stochastic frontier gravity model, whose specific expressions in logarithmic form are as follows:

$$\ln Trade_{ijt} = \alpha_1 + \alpha_2 \ln D_{ijt} + \alpha_3 \ln Z_{ijt} + v_{ijt} - \mu_{ijt} \quad (6)$$

where *Trade*, *D*, and *Z* denote trade volume, distance, and other control variables that affect trade volume, respectively.  $v_{ijt}$  follows a normal distribution  $N(0, \sigma_v^2)$ , which is a general random error term (mainly refers to the set of non-human unobservable factors).  $\mu_{ijt}$  represents the trade inefficiency term (mainly refers to the degree of human influence on trade). When the level of trade is optimal,  $\mu_{ijt} = 0$  when it indicates that the level of trade is not optimal (i.e., there is an efficiency loss),  $\mu_{ijt} > 0$ . In the time-varying decay model, the trade inefficiency term  $\mu_{ij}$  follows the truncated normal distribution  $\mu_{ijt} = \{\exp[-\eta(t-T)]\} \mu_{ij}$ . Where  $\eta$  is the parameter to be estimated. When  $\eta=0$  means that the trade inefficiency term does not change with time, i.e., it is equivalent to the time-invariant model; if  $\eta < 0$ ,  $\eta > 0$ , it means that the trade inefficiency term increases and decreases with time, respectively.

Battese & Coelli (1995) further extend the inefficiency term in the stochastic frontier model to be influenced by some human factors. *f* is a set of human factors that affect the trade inefficiency term. *g* is the error term in the trade inefficiency model.

Regarding the estimation of the stochastic frontier gravity model, the "two-step approach" used in the early days of using the stochastic frontier model for trade is to estimate the trade efficiency value in the first step and then to conduct a quadratic regression of the trade efficiency as the explanatory variable with the possible influencing factors. However, this approach has the problem of contradictory assumptions in the first and second steps. Therefore, the author uses the "one-step method" proposed by Battese and Coelli (1995) for estimation.

The author estimates the export, import, and total trade efficiency and potential of China and the UK based on the top 20 countries in China and India's respective trade, constituting a panel data of 31 countries including China and the UK and spanning the period 2007 to 2019. The stochastic frontier gravity model constructed on the basis of other scholars'

studies is set up as follows:

$$\ln T_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln P_{it} + \beta_4 \ln P_{jt} + \beta_5 \ln D_{ijt} + \beta_6 CONT + \beta_7 Comlang + v_{ijt} - \mu_{ijt} \quad (7)$$

$$\mu_{ijt} = \beta_0 + \beta_1 Rta_{ijt} + \beta_2 Time_{jt} + \beta_3 Triff_{jt} + \beta_4 \ln LP_{jt} + \beta_5 VA_{jt} + \beta_6 PS_{jt} + \beta_7 \ln MF_{jt} + \beta_8 TF_{jt} + \beta_9 BF_{jt} + \beta_{10} FF_{jt} + \omega_{ijt} \quad (8)$$

In the trade frontier model (7),  $T_{ijt}$  denotes the total trade between China and Britain.  $GDP_i$  and  $GDP_j$  denote the GDP of China and major trading countries respectively, reflecting the development level of countries *i* and *j*. The larger the *GDP*, the larger the bilateral trade volume, and the expected coefficient is positive.  $P_i$  and  $P_j$  denote the population size of China and major trading countries respectively, reflecting the number of consumers or economic pressure in countries *i* and *j*. If the population growth is faster than the *GDP* growth, the expected coefficient is negative. If the population growth is faster than the *GDP* growth, the expected coefficient is negative, otherwise the coefficient is positive.  $D_{ij}$  denotes the distance between the capital city of China and the major trading country, reflecting the trade barriers between country *i* and country *j*. The expected coefficient is negative. *CONT* denotes whether China shares a border with the major trading country, with 1 for border and 0 for otherwise. *Comlang* is a dummy variable for whether China shares a language with the major trading country, with 1 indicates a common language, otherwise 0.

In the trade inefficiency model (3), *Rta* indicates whether China and the major trading countries are the same regional economic organization, which is taken as 1, otherwise 0, and the expected sign is negative. *Time* is the average import turnaround time of the major trading countries to measure the level of trade facilitation, and the expected sign is positive. *Triff* indicates the weighted average tariff of the major trading countries, reflecting the tariff barriers between country *i* and country *j*, and the expected sign is positive. *LP* denotes the combined level of logistics performance of major trading countries, with larger values indicating more convenient logistics, and the sign is expected to be negative. *VA* and *PS* are the degree of democracy and political stability, respectively, with larger values indicating more favorable trade, and the sign is expected to be negative. *MF*, *TF*, *BF*, and *FF* denote the degree of monetary freedom, trade freedom, commercial freedom, and financial freedom of major trading countries, respectively. They are used to measure the level of market freedom of the country, and the larger the value, the freer the market is, and the sign is expected to be negative.

Data T for the empirical part are taken from the UNcomtrade database; *GDP*, *P*, *D*, *CONT*, *comlang*, and *Rta* data are from the CEPII database; *Triff*, *Time*, and *LP* data are from the World Bank World Development Indicators database, and *VA* and *PS* data are from the World Bank Global Governance database; *MF*, *TF*, *BF*, and *FF* data Source with World Economic Forum.

### 4.2. Analysis of empirical results

As shown in Table7 (Appendix table), considering that the variation of trade influencing factors between China and Britain will lead to the trade efficiency is not constant, a time-varying stochastic frontier gravity model is proposed in the paper, but to verify the robustness of the model, I use two regressions of time-invariant (*Ti*) and time-varying (*Tvd*) with

total trade as the explanatory variable, respectively. In the  $Ti$  regression, the variance of the trade inefficiency term reaches 0.973 of the total variance, indicating the suitability of using the stochastic frontier gravity model with the trade inefficiency term. In contrast, it is found that in  $Tvd$ , the variance of the trade inefficiency term accounts for a reduced share of the total variance, but it also reaches 0.687, indicating that the trade inefficiency term is the main factor affecting trade between China and the UK, further determining the necessity of using the time-varying stochastic frontier gravity model.

In the stochastic frontier gravity model, from the estimation results of both  $Tvd$  and  $TI$  methods: the estimated coefficients of  $lngdp_i$ ,  $lngdp_j$ , and  $Comlang$  are all greater than zero and all are significant at the 1% level, indicating that the increase in GDP and having a common language have a facilitating effect on the growth of Sino-British bilateral trade.  $lnD_{ij}$  coefficient has a negative sign, indicating that the greater the distance hinders the growth of Sino-British trade. The coefficients of  $lnP_i$  are all negative, but do not pass the significance test in the  $Tvd$  regression, indicating that the increase in China's population has no significant effect on the growth of Sino-British trade.  $lnP_j$  coefficient sign turns from negative to positive and passes the 1% significance test, indicating that the increase in the population of major trading countries can promote the growth of Sino-British trade.  $CONT$  coefficient turns from positive to negative, but does not pass the 5% significance test, indicating that the common border between China and major trading countries has no significant effect on Sino-British trade.

In the trade inefficiency model, the coefficients of  $Rta$ ,  $PS$ ,  $MF$ ,  $BF$ , and  $FF$  are all negative, as expected, and pass the significance test, indicating that belonging to the same regional economic organization, political stability, monetary freedom, commercial freedom, and financial freedom increase can effectively reduce trade frictions (reduce the value of the trade inefficiency term) and improve the trade efficiency between China and the UK. the coefficients of  $Time$ ,  $Triff$ ,  $LP$ ,  $VA$ , and  $TF$  have negative coefficients, among which the effects of  $Time$  and  $Triff$  on China-UK trade efficiency are as expected, indicating that the increase of trade barriers can increase the value of the trade inefficiency term and thus reduce China-UK trade efficiency. However, the coefficients of  $LP$ ,  $VA$  and  $TF$  are not as expected. the possible reason for the positive coefficients of  $LP$  and  $TF$  is that with the facilitation of logistics and trade freedom in the UK, trade between China and the UK is replaced by trade between other countries. the possible reason for the positive coefficient of  $VA$  is that although this indicator reflects the trade environment, it also reflects the difference in cultural perceptions between China and the UK to a certain extent, which hinders the improvement of trade between the two countries. efficiency.

### 4.3. China-UK Trade Potential

As shown in Table8 (Appendix table), considering From 2007 to 2019, trade efficiency between China and the UK increased from 0.24 to 0.28, slightly increasing in a stable manner, but the overall trade efficiency is low, and there is more room for trade cooperation between the two countries to further improve trade efficiency. Among the 30 trading counterparts, trade efficiency ranking, however, declined from 21st to 23rd in 2019, indicating that China-UK trade has been constrained by some factors over the past 13 years, and

the intensity of hindrance has increased. As the level of Sino-British trade cooperation has increased, the trade potential of the two countries has continued to increase, from 164.654 billion U.S. dollars in 2007 to 311.075 billion U.S. dollars in 2019, an increase of about one times, with an average annual growth rate of %. Trade potential also continues to increase with trade efficiency and is greater than expandable trade potential. Expandable trade potential has grown from \$125.211 billion in 2007 to \$224.971 billion in 2019. At the same time, the trade share is from 2007 to 2019, in the oscillation of a slight decline, the lowest in 2019 also accounted for 72.32%, indicating that the trade potential of China and the United Kingdom is gradually released, but the vast majority of trade potential between China and the United Kingdom is still eager to be tapped by both sides.

## 5. Conclusions and Recommendations

Based on the analysis of the current trade situation between China and the UK, this paper measures the trade relations between China and the UK using the trade integration degree, export concentration degree and trade complementarity index. The results show that: firstly, trade cooperation between China and Britain is developing well, and the scale of mutual exports between the two countries continues to grow, but China is always in a trade surplus position, and the surplus continues to expand. Second, the overall trade combination between China and Britain is small, and the trade combination of China's exports to Britain is larger than the trade combination of Britain's exports to China, indicating that the trade between China and Britain is relatively loose, and there is still a lot of room for trade cooperation between the two countries. Third, the export concentration between China and Britain is high, and the concentration of China's exports to Britain is relatively stable between 0.56 and 0.58, and the concentration of Britain's exports to China is around 0.5, but there is a downward trend, indicating that Britain's exports to China have a trend of diversification, and its export potential to China is large. Fourth, the comprehensive trade complementarity indexes between the two countries all change around 1, and the trade complementarity between China and Britain is high; however, the trade complementarity between China's exports and Britain's imports has a decreasing trend, while the trade complementarity between Britain's exports and China's imports is more stable. Meanwhile, the complementary products between the two countries do not overlap; China has good complementarity with the UK in exports of SITC6, SITC7 and SITC8, and the UK has good complementarity with China in exports of SITC2, SITC3 and SITC5. And in the stochastic frontier gravity model, the author examines the factors influencing the trade potential and efficiency between China and the UK. The empirical test finds that the establishment of free trade area, tariff concessions, reduction of average import turnaround time, and increase of monetary freedom, commercial freedom, and financial freedom are effective in improving the trade efficiency between China and the UK.

In order to improve the efficiency of Sino-British trade and release the trade potential, in view of the findings of this paper, the following suggestions are made:

First, narrow the Chinese goods trade surplus and improve the imbalance of China-UK goods trade. The UK's continuously expanding trade deficit with China will undoubtedly hinder further cooperation in trade between

China and the UK. However, the trade between China and Britain does not overlap in terms of complementary products. Therefore, China can increase the imports of SITC2, SITC3 and SITC5 products with high complementarity between British exports and Chinese imports, as well as the imports of service products, in order to alleviate the UK's trade deficit with China. The trade combination between the two countries is increasing, with a high degree of complementarity between the two countries' exports and a low degree of intra-industry competition. These characteristics indicate that the trade potential between China and the UK is still large.

Second, strengthen trade cooperation between the two countries and improve the level of trade facilitation between the two countries. The level of trade facilitation is an important factor affecting trade growth. The empirical test found that the increase of the average turnaround time of imports can significantly improve the non-efficiency of trade between China and the UK. It is necessary for China and the UK to strengthen trade cooperation, further reduce trade clearance procedures and shorten clearance time; enhance administrative transparency at customs and border crossing points to reduce non-tariff barriers between the two countries and improve the level of trade facilitation between the two countries.

Thirdly, mutual reduction of tariff barriers, low-level and loose trade cooperation at first, and then gradually develop into standardized and institutionalized trade cooperation, and propose and promote the construction of a free trade area between the two countries at an appropriate time. Empirical tests show that both tariff reduction and FTA construction are conducive to the improvement of China-UK trade efficiency and potential. With the completion of Britain's exit from the European Union, Britain urgently needs to establish with the world's major economies in order to build the losses brought by the exit. And China in the 15 FTAs that have been established, FTA partner countries have the characteristics of small economic volume and low development, China has the need to further optimize the FTA network. In 2018, at the 13th meeting of the Sino-British Joint Commission on Economic and Trade, the two countries agreed to "actively consult on the possibility of building a high-level FTA between the two sides after the UK leaves the EU". Therefore, with the UK prioritizing the establishment of FTAs with the EU, the US and Commonwealth countries, China and the UK can first strengthen trade cooperation and then establish a free trade area when the time is ripe to promote the trade potential of both countries.

Fourthly, using financial institutions or products such as ADB, EBRD, Silk Road Fund and Shanghai-Lun Tong to carry out Sino-British cooperation in the financial and investment fields in order to open up investment and financing paths between the two countries, as well as enhance financial liberalization and commercial liberalization between the two countries. The financial service industry is the pillar industry of the UK, and the level of development of the service industry and investment environment is better. However, China's service trade imports to the UK in 2019 were only \$21.88 billion, a quarter of the top service trade importer (the US). And imports of tourism services to the UK accounted for 63.2%, while imports of financial services products, which have greater advantages, were less. At the same time, both China and the UK are member countries of financial institutions such as the ADB and the EBRD, China and the UK can fully open up two-way investment and

financing paths for this platform, enhance regular information sharing, strengthen cross-border regulatory dialogue and closer regulatory cooperation between institutions, so that the two sides can gradually deepen and open up cooperation and capital markets for financial market interconnection. This is not only beneficial for the UK to solidify its position in the financial sector after Brexit and increase the import of financial services to the UK; it can also prompt China to be able to learn from the UK's advanced knowledge of financial services and thus improve its financial services.

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## Appendix table

**Table 1.** Current status of bilateral trade between China and the UK

Year	export	import	total	balance	Share 1	Share 2	Share 3	Share 4
2007	316.66	75.81	392.47	240.86	2.6	13.47	1.67	5.01
2008	360.73	90.66	451.38	270.07	2.52	13.93	1.88	4.69
2009	312.77	80.54	393.31	232.24	2.60	14.87	2.24	4.45
2010	387.67	112.94	500.61	274.73	2.46	16.25	2.68	4.35
2011	441.22	140.89	582.11	300.34	2.32	16.34	2.72	4.45
2012	462.97	156.01	618.98	306.96	2.26	18.01	3.29	4.17
2013	509.42	180.85	690.27	328.57	2.31	18.51	3.34	4.54
2014	571.41	260.77	832.18	310.64	2.44	19.65	5.20	4.21
2015	595.67	276.25	871.92	319.42	2.62	21.56	5.92	4.42
2016	556.64	181.42	738.06	375.22	2.65	20.43	4.41	4.01
2017	567.14	213.68	780.82	353.45	2.51	19.24	4.85	3.74
2018	569.88	277.02	846.9	292.86	2.28	19.59	5.64	3.86
2019	622.76	300.36	923.12	322.40	2.49	20.26	6.47	3.76

**Data source:** UNcomtrade database. China-UK exports are China's reported exports to the UK, Share1 is China's exports to the UK as a share of China's exports, and Share2 is China's exports as a share of world exports. Share3 is Britain 's exports to the China as a share of Britain 's exports, and Share4 is Britain 's exports as a share of world exports.

**Table 2.** Trade integration between China and the UK

Year	Integration 1	Integration 2	Year	Integration1	Integration2
2007	0.35	0.17	2014	0.44	0.35
2008	0.38	0.19	2015	0.44	0.41
2009	0.39	0.20	2016	0.44	0.29
2010	0.39	0.21	2017	0.45	0.33
2011	0.39	0.20	2018	0.43	0.36
2012	0.39	0.23	2019	0.44	0.38
2013	0.43	0.23			

**Data source:** UNcomtrade database. Integration1 is the trade integration when China exports to the UK and the UK imports. integration2 is the trade integration when the UK exports to China and China imports.

**Table 3.** Concentration of trade between China and Britain

Year	Concentration1	Concentration2	Year	Concentration1	Concentration2
2007	0.58	0.50	2014	0.58	0.56
2008	0.58	0.52	2015	0.58	0.53
2009	0.58	0.49	2016	0.59	0.52
2010	0.58	0.55	2017	0.58	0.51
2011	0.57	0.55	2018	0.56	0.46
2012	0.57	0.60	2019	0.56	0.46
2013	0.58	0.62			

**Data source:** UNcomtrade database. Concentration1 is the concentration of trade when China exports to the UK and the UK imports, Concentration2 is the concentration of trade when the UK exports to China and China imports.

**Table 4.** China-UK Composite Trade Complementarity Index

Year	Complementarity1	Complementarity2	Year	Complementarity1	Complementarity2
2007	1.01	0.94	2014	1.02	0.97
2008	0.97	0.93	2015	1.01	0.98
2009	0.84	0.88	2016	0.96	0.97
2010	0.97	0.93	2017	0.97	0.96
2011	0.97	0.94	2018	0.97	0.97
2012	0.91	0.98	2019	0.93	0.94
2013	0.99	0.98			

**Data source:** UNcomtrade database. Complementarity1 is the trade complementarity index when China exports to the UK and the UK imports, while Complementarity2 is the trade complementarity index when the UK exports to China and China imports.

**Table 5.** Complementarity index between Chinese exports and UK imports of various products

Year	SITC									
	0	1	2	3	4	5	6	7	8	9
2007	0.68	0.23	0.18	0.15	0.03	0.41	0.98	1.13	2.79	0.08
2008	0.59	0.22	0.19	0.17	0.04	0.44	1	1.1	2.76	0.07
2009	0.57	0.23	0.12	0.14	0.03	0.37	0.91	0.88	2.39	0.13
2010	0.6	0.25	0.11	0.12	0.02	0.48	1.01	1.15	2.58	0.06
2011	0.6	0.29	0.11	0.12	0.02	0.55	1.08	1.17	2.6	0.06
2012	0.56	0.24	0.09	0.14	0.02	0.52	1.05	1.05	2.35	0.03
2013	0.6	0.23	0.1	0.12	0.03	0.54	1.09	1.22	2.55	0.02
2014	0.56	0.24	0.12	0.12	0.02	0.56	1.03	1.26	2.48	0.02
2015	0.55	0.26	0.12	0.14	0.02	0.54	0.99	1.21	2.22	0.02
2016	0.55	0.25	0.11	0.14	0.02	0.47	0.96	1.15	2.06	0.14
2017	0.6	0.25	0.11	0.2	0.03	0.57	1.03	1.11	2.12	0.1
2018	0.64	0.24	0.13	0.23	0.05	0.55	1.09	1.11	2.09	0.1
2019	0.56	0.2	0.11	0.22	0.05	0.48	1.09	1.04	1.94	0.39

**Data source:** UNcomtrade database.

**Table 6.** Complementarity index of various products exported from the UK to China for import

Year	SITC									
	0	1	2	3	4	5	6	7	8	9
2007	0.18	0.44	2.53	1.15	0.5	1.53	0.61	0.96	0.76	0.13
2008	0.17	0.51	3.16	1.31	0.35	1.42	0.56	0.86	0.69	0.25
2009	0.17	0.53	2.79	1.35	0.4	1.46	0.65	0.78	0.59	0.23
2010	0.2	0.58	2.44	1.28	0.28	1.55	0.55	0.83	0.65	0.83
2011	0.2	0.76	2.43	1.18	0.19	1.41	0.5	0.80	0.55	2.2
2012	0.23	0.85	2.46	1.72	0.26	1.47	0.47	0.80	0.51	1.57
2013	0.23	0.74	1.95	1.18	0.24	1.23	0.42	0.77	0.44	4.08
2014	0.29	0.87	2.17	1.29	0.21	1.3	0.47	0.92	0.49	2.56
2015	0.33	1.01	2.09	1.31	0.2	1.42	0.4	0.91	0.54	3.11
2016	0.33	1.04	2.07	1.23	0.16	1.23	0.39	1.11	0.6	1.53
2017	0.36	1.12	2.48	1.84	0.24	1.37	0.41	0.91	0.55	1.35
2018	0.4	0.99	2.13	2.02	0.26	1.15	0.39	0.85	0.51	2.67
2019	0.48	0.98	1.98	2.07	0.28	1.08	0.38	0.91	0.58	1.42

**Data source:** UNcomtrade database.

**Table 7.** Model regression result

	Ti	se	Tvd	se
<b>Stochastic frontier gravity model</b>				
<i>lngdp<sub>i</sub></i>	0.628***	(0.08)	0.596***	(0.20)
<i>lngdp<sub>j</sub></i>	0.810***	(0.06)	0.733***	(0.04)
<i>lnP<sub>i</sub></i>	-4.922***	(1.89)	-5.493	(4.55)
<i>lnP<sub>j</sub></i>	-0.123**	(0.05)	0.238***	(0.04)
<i>Ind<sub>ij</sub></i>	-0.658***	(0.09)	-0.385***	(0.05)
<i>Cont</i>	0.403***	(0.14)	-0.116	(0.11)
<i>Comlang</i>	0.636**	(0.25)	0.722***	(0.07)
<i>_cons</i>	52.375**	(24.89)	56.756	(59.85)
<b>Trade inefficiency model</b>				
<i>Rta</i>			-0.654***	(0.10)
<i>Time</i>			0.045**	(0.02)
<i>Triff</i>			0.026*	(0.01)
<i>LP</i>			0.273***	(0.08)
<i>VA</i>			0.750***	(0.06)
<i>PS</i>			-0.650***	(0.06)
<i>MF</i>			-0.012**	(0.01)
<i>TF</i>			0.032***	(0.01)
<i>BF</i>			-0.008***	(0.00)
<i>FF</i>			-0.022***	(0.00)
<b>gamma</b>	0.973	0.02	0.687	0.062

<b>sigma_u2</b>	0.826	0.623	0.112	0.034
<b>sigma_v2</b>	0.023	0.001	0.051	0.031
<b>N</b>	390		390	

**Note:** \*\*\*, \*\*, \* indicate passing the significance level test of 1%, 5%, and 10%, respectively, with standard errors in parentheses.

**Table 8.** China-UK Trade Potential

<b>Year</b>	<b>trade efficiency ranking</b>	<b>trade efficiency</b>	<b>Actual trade volume</b>	<b>Trade potential</b>	<b>Scalable trade potential</b>	<b>Trade share</b>
2007	21	0.24	394.43	1646.54	1252.11	76.04
2008	22	0.25	456.15	1821.31	1365.17	74.96
2009	22	0.23	391.55	1724.63	1333.08	77.30
2010	22	0.24	500.72	2068.84	1568.12	75.80
2011	23	0.24	586.79	2483.50	1896.72	76.37
2012	23	0.24	630.98	2675.39	2044.41	76.42
2013	22	0.25	700.21	2793.75	2093.54	74.94
2014	21	0.25	808.68	3203.35	2394.68	74.76
2015	21	0.25	785.01	3095.44	2310.44	74.64
2016	23	0.25	743.46	3004.89	2261.43	75.26
2017	23	0.26	790.42	3022.39	2231.97	73.85
2018	24	0.23	808.81	3469.36	2660.55	76.69
2019	23	0.28	861.03	3110.75	2249.71	72.32

**Note:** Scalable trade potential = trade potential - actual trade volume.